UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/058,426	01/30/2002	Daisuke Komada	020060	4298

23850 7590 07/25/2003

ARMSTRONG,WESTERMAN & HATTORI, LLP
1725 K STREET, NW
SUITE 1000
WASHINGTON, DC 20006

EXAMINER	
BARRECA, NICOLE M	
ART UNIT	PAPER NUMBER
1756	4

DATE MAILED: 07/25/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No.	Applicant(s)
	10/058,426	KOMADA ET AL.
	Examiner	Art Unit
	Nicole M. Barreca	1756

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-12 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-12 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 30 January 2002 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

1. Claims 1-12 are pending in this application.

Drawings

2. The drawings are objected to because there is no Fig. 10F or Fig.10G, but theses figures are disclosed in the specification. (There are however two sheets of Fig. 10L and Fig.10 M.) A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 9 and 10 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 9 recites "etching the third film by using the partially etched third film as a mask. Since a layer can not be etched using itself as a mask, it is unclear what layer is meant to be etched and which layer is meant to be the partially etched layer used as the mask.

5. Claims 1-10 recite forming a film made of "hydrogenated silicon carbide". While there are many definitions of "hydrogenated silicon carbide" used in the prior art, the applicant describes "hydrogenated silicon carbide" in the specification as silicon carbide which contains hydrogen (p.17) and this is the definition used by the examiner.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by Olsen (EP 926 715).

8. Olsen discloses a fabrication method for an integrated circuit. An oxide layer and/or a thin dielectric layer, such as silicon nitride (applicant's first film being made of a material having a different etch resistance from SiC), is formed on a semiconductor wafer. This is followed by the deposition of a silicon carbide layer (applicant's second film). The silicon carbide layer is deposited using hydrogen containing sources gases, such as silane/methane or trimethylsilane, and is therefore hydrogenated. A photoresist is deposited and patterned. The silicon carbide and other underlying layers are etched [00115]-[0016]. The fifth embodiment teaches etching the SiC layer using NF3/CHF3/CF4/Ar/O2/H2 [0026].

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 2, 5, 7 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li (US 2002/0173322).

11. Li discloses a method for plasma etching of silicon carbide with selectivity to an underlying and/or overlying dielectric layer (abstract). The silicon carbide may be hydrogenated [0019]. The preferred etching recipe comprises a fluorocarbon gas of CH3F, with O2 and Ar. The etching rate of the silicon carbide layer can be further increased by adding another F-containing gas such as NF3 to the CH3F [0053]. Substrate 42 is a silicon wafer which may include metallization (conductive member on insulating substrate) which is not shown. Photoresist 32 is patterned with opening 30 and overlies a stack of layers. Mask 33 of silicon dioxide, silicon nitride, or silicon carbide (applicant's third film of SiC), first low-k dielectric layer 34 (applicant's second film of insulating material having a different etching resistance from SiC), a first etch stop layer 36 of silicon nitride or silicon carbide (applicant's first film of SiC), a second low-k dielectric layer 38, a second etch stop layer 40 of silicon nitride or silicon carbide are deposited over the substrate. Figure 2B illustrates the structure after etching wherein opening 30 extends through layer 33 (etching third film using resist mask) and

layer 34 (etching second film using resist mask). Figure 2C illustrates the structure after repatterning for via 44. Figure 2D shows the structure after further etching, including layers 34, 36 (etching first, second films). See [0045]. Examples of materials for the low-k dielectric layer include fluorinated silicon oxide (FSG), silicate glasses such as boron phosphate silicate glass (BPSG), fluorinated silicate glass and phosphate silicate glass (PSG), carbon doped silicate glass, silsequioxane glass and organic polymer materials [0047]. The dual damascene recess is then typically filled with a liner (barrier), followed by a conductive material [0012].

Li does not disclose that the etching rate of the second film is faster than the etching rate of the first film as recited in claim 7. However Li does teach that the first film (36) is an etch stop layer (i.e. the etching of the second film (34) continues until the first film (36) is reached, as illustrated in Fig.2B). It would have been obvious to one of ordinary skill in the art that the etching rate of the second film was faster than the etching rate of the first film because Li teaches that the first film is an etch stop layer and it is known in the art that the etching rate of an insulating layer (second film) is faster than tits etch stop layer (first layer). Li does not explicitly disclose that the resist film is ashed and removed. Li does teaches that in Fig.2C the structure is repatterned. It would have been obvious to one of ordinary skill in the art that the photoresist layer in the method of Li was removed because Li teaches that the structure is repatterned and it is known in the art that the original patterned resist layer is removed before the second patterned resist layer can be formed.

12. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li as applied to claim 2 above, and further in view of Bajaj (US 6,261,157).

13. Li is silent on the material used for the conductive region and the barrier layer and does not disclose that the conductive region is copper wiring and the barrier layer is Ta, TaN, Ti and TiN. Bajaj teaches that in a typical semiconductor device the conductive layer is formed by depositing copper, while the barrier layer is formed by depositing tantalum (col.6, 54-63). It would have been obvious to one of ordinary skill in the art to have the conductive region be formed of copper and to have the barrier layer be formed of Ta in the method of Li because Baja teaches that in a typical semiconductor device the conductive layer is formed by depositing copper, while the barrier layer is formed by depositing tantalum.

14. Claims 6, 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li as applied to claims 2, 7, or 9 respectively, above, and further in view of Dabbaugh (US 6,362,094).

15. Li is silent on the conditions for the deposition of the hydrogenated silicon carbide layer and does not disclose that the silicon carbide film is deposited by CVD using tetramethylsilane and carbon dioxide in a flow rate ratio of 0.2 to 0.6. Dabbaugh teaches semiconductor manufacturing method using hydrogenated silicon carbide. Dabbaugh teaches that the hydrogenated silicon carbide layer may be conventionally formed be plasma enhanced CVD using a silane source and an oxygen source. Tetramethylsilane may be used as the silane source, while carbon dioxide layer be used for the oxygen source (col.3, 47-67). It would have been obvious to one of ordinary skill

in the art to deposit the hydrogenated silicon carbide layer by CVD using tetramethylsilane and carbon dioxide because Dabbaugh teaches that this a known method for deposition of hydrogenated silicon carbide. Dabbaugh is silent on the flow rates of the source gases and does not disclose that the tetramethylsilane and the carbon dioxide flow rates are in a ratio of 0.2 to 0.6. Source gas flow rates are known in the art to be result-effective variables. It would within the ordinary skill of one in the art to determine the optimal flow rates ratio for the tetramethylsilane and carbon dioxide in the method Li in view of Dabbaugh by routine experimentation and to have the ratio be 0.2 to 0.6, if required, because source gas flow rates are result-effective variables and the discovery of an optimum value of a result effective variable is ordinary within the skill of the art, as taught by *In re Boesch* (617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

16. Claims 11 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li in view of Dabbaugh.

17. Li discloses a method for plasma etching of silicon carbide with selectivity to an underlying and/or overlying dielectric layer (abstract). Substrate 42 is a silicon wafer which may include metallization (conductive member on insulating substrate) which is not shown. Photoresist 32 is patterned with opening 30 and overlies a stack of layers. Mask 33 of silicon dioxide, silicon nitride, or silicon carbide, first low-k dielectric layer 34 (applicant's second film of insulating material having a different etching resistance from SiC), a first etch stop layer 36 of silicon nitride or silicon carbide (applicant's first film of SiC), a second low-k dielectric layer 38, a second etch stop layer 40 of silicon nitride or silicon carbide are deposited over the substrate. Figure 2B illustrates the structure after

etching wherein opening 30 extends through layer 33 and layer 34. Figure 2D shows the structure after etching, including layer 34 (etching second film). See [0045]. Examples of materials for the low-k dielectric layer include fluorinated silicate glass [0047].

Li does not explicitly disclose that the etching rate of the second film is faster than the etching rate of the first film. However Li does teach that the first film (36) is an etch stop layer (i.e. the etching of the second film (34) continues until the first film (36) is reached, as illustrated in Fig.2B). It would have been obvious to one of ordinary skill in the art that the etching rate of the second film was faster than the etching rate of the first film because Li teaches that the first film is an etch stop layer and it is known in the art that the etching rate of an insulating layer (second film) is faster than its etch stop layer (first layer).

Li is silent on the conditions for the deposition of the silicon carbide layer and does not disclose that the silicon carbide film is deposited by CVD using tetramethylsilane and carbon dioxide in a flow rate ratio of 0.2 to 0.6. Dabbaugh teaches semiconductor manufacturing method using silicon carbide. Dabbaugh teaches that the silicon carbide layer may be conventionally formed using plasma enhanced CVD using a silane source and an oxygen source. Tetramethylsilane may be used as the silane source, while carbon dioxide layer be used for the oxygen source (col.3, 47-67). It would have been obvious to one of ordinary skill in the art to deposit the silicon carbide layer by CVD using tetramethylsilane and carbon dioxide because Dabbaugh teaches that this a known method for deposition of hydrogenated silicon

carbide. Dabbaugh is silent on the flow rates of the source gases and does not disclose that the tetramethylsilane and the carbon dioxide flow rates are in a ratio of 0.2 to 0.6. Source gas flow rates are known in the art to be result-effective variables. It would within the ordinary skill of one in the art to determine the optimal flow rates ratio for the tetramethylsilane and carbon dioxide in the method Li in view of Dabbaugh by routine experimentation and to have the ratio be 0.2 to 0.6, if required, because source gas flow rates are result effective variables and the discovery of an optimum value of a result-effective variable is ordinary within the skill of the art, as taught by *In re Boesch* (617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Conclusion

18. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. 2003/0068582 is the Patent Application Publication for the present application.

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nicole M. Barreca whose telephone number is 703-308-7968. The examiner can normally be reached on Monday-Thursday (8:00 am-6:30 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Nicole Barreca
Patent Examiner
Art Unit 1756
Nicole Barreca
July 22, 2003